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## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>CL1453PCT1</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/US 03/33696</b>	International filing date (day/month/year) <b>, 21/10/2003</b>	(Earliest) Priority Date (day/month/year)
Applicant  <b>E.I. DU PONT DE NEMOURS AND COMPANY</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established by this Authority to read as follows:

**YARN**

5. With regard to the **abstract**,

- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

- ☐ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.
- ☐ None of the figures.

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 03/33696

## Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A yarn including discontinuous and, optionally, continuous filaments.

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/33696

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D02G3/22 D02G3/34

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D02G D01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 924 086 A (DU PONT) 24 April 1963 (1963-04-24)	5,7
A	claim 1; example 1 ---	1,9
A	DE 101 61 419 A (TEMCO TEXTILMASCHKOMPONENT) 18 June 2003 (2003-06-18) claim 1 ---	1,5,9
A	US 5 640 745 A (SCHWARZ, ERWIN; ET AL) 24 June 1997 (1997-06-24) claim 1 ---	1,5,9
A	US 4 403 470 A (NELSON THOMAS L) 13 September 1983 (1983-09-13) example 2 ---	1,5,9
	--- -/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*Z\* document member of the same patent family

Date of the actual completion of the international search

3 June 2004

Date of mailing of the international search report

22/06/2004

Name and mailing address of the ISA

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PCT/US 03/33696

Relevant to claim No.
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 03/33696

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 924086	A	24-04-1963	US 3091913 A	04-06-1963
DE 10161419	A	18-06-2003	DE 10161419 A1	18-06-2003
			WO 03050336 A1	19-06-2003
US 5640745	A	24-06-1997	WO 9523886 A1	08-09-1995
			CN 1124045 A ,B	05-06-1996
			DE 19580019 C1	19-09-1996
			DE 19580019 D2	25-01-1996
			EP 0696331 A1	14-02-1996
			GB 2287256 A ,B	13-09-1995
			JP 8510019 T	22-10-1996
			RU 2119979 C1	10-10-1998
US 4403470	A	13-09-1983	DE 3279032 D1	20-10-1988
			EP 0083221 A2	06-07-1983
GB 1058551	A	15-02-1967	NONE	

stretching it and the elongation-at-break of the filament. This sum is hereinafter in the description and claims referred to as the "extensibility factor" of the filaments. When

5 feeding untwisted filaments to the turbulent fluid zone, the increase in length required to straighten the filaments in the product is determined by the ratio of the rate of feeding them to and the rate of withdrawing them from the turbulent zone. For the purpose of the present invention the relative rates of feed of the groups of filaments are such as to give a product in which the extensibility factor of one group of filaments is substantially higher than that of another group so that on applying a stretch intermediate between the two extensibility factors one group of filaments is broken while the other is not.

10 The filaments which break appear in the product as bundles of filaments distributed at random or unevenly along the length of the unbroken components and interentangled therewith. This effect obtained is illustrated in the accompanying drawings where, in Figure 1 the filaments of yarn 3 are shown entangled with the filaments of yarn 4. Normally, the yarn with the lowest rate of feed becomes a core yarn 3 and yarn components with higher rates of feed become effect yarns 4, giving a composite textured yarn of at least two components with the filaments of each interentangled with one another.

15 The turbulent fluid zone may be produced by means of a yarn-bulking jet of the type described in British Patent No. 732929 or United States Patent No. 2,852,906 adapted to cause the individual filaments of the yarn to become convoluted and interentangled to produce a bulked yarn as illustrated in Fig. 2 of the accompanying drawings.

20 Other suitable fluid jets for use in the present invention are described in British Patents Nos. 842742 and 905895. Jets having a forwarding effect on the yarn are particularly desirable. Many of these fluid jets, with appropriate modification as to design and/or fluid used, are suitable as wrapper jets, the essential function of which is only further to consolidate the multi-component structure. While air at room temperature is most convenient for use in these fluid jets, other fluids may be used, such as hot air, steam or other heated fluids. The composite structure may be stretched, if desired, until the filaments with the highest extensibility factor are at their original length but not sufficiently to break these filaments nor to separate the components completely one from another.

25 The bundles constitute distinct and separate groups of discontinuous filaments, completely surrounding the core member at intervals and sufficiently interentangled there-

with to provide a stable slub yarn. These bundles, or slubs, are distinct or separate in that they are each composed of a distinct or separate body of discontinuous filaments, though there may be, of course, some contact between individual bundles. The length of these bundles may vary along the length of the core component.

30 Although the multicomponent yarns of this invention may be, at least in part, bulky yarns, they are quite different from the bulky yarns produced according to British Patent No. 732929 and United States Patent No. 2,852,906. Because of the difference in the rates of feed between the several components of the yarns of this invention, the filaments bunch together and are not distributed uniformly along the length of the yarn. This results in a slub effect caused by variations in denier along the yarn due to the fact that in some regions a greater quantity of material is present than in other regions. The resulting change in over-all denier gives an effect similar to dupioni or linen-type yarns and is most apparent and attractive when the yarn is woven or otherwise processed into a fabric.

35 In the simplest preferred embodiment of this invention, the composite yarn is made up of two components, the initial core yarn (prior to breaking) having a substantially lower extensibility factor than that of the initial effect yarn (preferably less than about 1/2), because the latter is fed to the fluid jet at a substantially higher rate—preferably at least twice as fast (twice the unit length per unit time). When this composite yarn is subsequently stretched, the core yarn will break randomly and will form along the threadline a series of slubs giving the composite yarn a variable denier. The initial effect yarn which during the processing is fed into the bulking jet at a much higher rate than the core yarn has a higher extensibility factor, thereby permitting it to remain unbroken during the stretching process which brakes the initial core component. Thus, a reversal of function of the two components occurs, the initial core component becoming the effect component of the final composite yarn while the initial effect component becomes the core component of the final yarn product. During the stretching-breaking step broken sections retract while the unbroken members are elongated and the short bulked lengths become knotted even more firmly into the composite structure. This bunching effect occurs at random intervals along the length of the composite yarn and the frequency of slub sections can be adjusted and controlled by variation of relative rates of feed and denier of components and conditions of breaking. In addition, bulking conditions such as total speed, air pressure, and jet adjustment can be varied to influence

the bulkiness, the degree of entanglement and the degree of loopiness, and thus the eventual physical properties and appearance of the composite yarn.

- 5 An alternative procedure consists in applying the stretch simultaneously with the bulking by withdrawing the composite material from the turbulent zone at such a speed that the stretch exceeds the extensibility factor of the group or groups of filaments fed at a lower rate and they are broken while the group or groups fed at the higher rate remain unbroken. Preferably the filaments which are to remain unbroken are fed at at least twice the speed of those which are to be broken. Further to obtain a product in which the core yarn is substantially straight, which is a preferred form, the rate of withdrawal of the composite product may be substantially equal to the rate of feed of the filaments which are to constitute the core yarn or preferably 1-2% lower to provide for increased entanglement of the slub component. A ratio of 2:1 in the feed speeds of the core and slub components gives satisfactory results but higher ratios up to about 50:1 may be used.

- The bundles, or slubs, may be further consolidated with the core member by any one of many twisting or treating procedures, such as by a downtwister, spinning frame, wrapping jets, such as disclosed in British Patent No. 871,112 and Application No. 26230/59 (Serial No. 924089), or by a chemical treatment, such as sizing or plasticizing with either heat or solvent. The wrapper jet procedure is preferred in that the slub bundles are then more tightly wrapped completely around the core member. Furthermore, the use of such wrapper jets does not limit the processing speed. In this wrapper jet procedure, the composite product coming from the turbulent zone is fed into a passageway into which a jet of fluid is fed tangentially and hence a torque is applied thereto which wraps the filament bundles constituting the slubs round the core yarn. The vortex zone created by the tangential jet is hereinafter in the claims referred to as a "zone of fluid torque".

- A schematic drawing of a suitable apparatus for the process of this embodiment of the invention is shown in Figures 5 and 6 of the accompanying drawings. Core component 8 and slub component 9 are fed off bobbins 10 and 11 respectively into a fluid bulking jet 12 of the type described in British Patent No. 732929 and United States Patent No. 2852906. The composite yarn structure is then fed into the passageway 14 (see cross-sectional view of Figure 6, taken along line 6-6 of Figure 5) of wrapping jet 15 where it is subjected to a blast of fluid entering through orifice 16, which enters passageway 14 tangentially and then the yarn is wound

up on roll 17. For high speed operation, a snubber bar 18 may be placed between the two jets to prevent excessive backing-up of the twist imparted in the wrapping jet into the fluid bulking jet. Tension device 19 may also be provided to control more definitely the tension on core component 8.

Microscope views of two such composite yarns are shown in Figure 3 and 4 of the accompanying drawings, which show bundles 5 and 5' wrapped completely around core members 6 and 6'. The entanglement produced is generally obscured in the twisted areas but is clearly indicated at 7.

By this invention it is possible to achieve a wide range of varying denier yarns. Size and character of the individual slubs, frequency of occurrence of slubs, variation of maximum and minimum denier, and the amount of residual bulkiness can be easily controlled and regulated.

Various combinations of fluid pressures between the various jet elements may be used to produce variation in the size and length of the discontinuous filament bundles. Similar effects may be achieved by varying the rates of feed of the various components and the tension on the core component during the treating process.

Different rates of feed result in varying composite yarn structures and the different operating conditions of the bulking fluid jet and the wrapping jet give different effects in the yarns produced because of the varying extent of interentanglement and interpenetration of the yarn components of the structure. Jet air pressure may be fluctuated during the formation of the composite structure to produce variations in degree of entanglement or during the wrapping to produce variations in degree of wrapping.

Short period denier variations in the intermediate yarn product (prior to any breaking) of this invention are obtained simply by passing the yarn simultaneously through a fluid jet and then stretching without breaking. Concentration of effect yarn along the composite yarn length can be accentuated by applying intermittent tension by means of a pinching or dragging device to the yarn or by interrupting momentarily the flow of one or more of the yarn components with higher rates of feed. Thus, while over a long length, delivery of this component may be constant, there can be short period fluctuations of several hundred per cent, and the composite yarn denier will vary correspondingly. Interruption of effect yarn flow can be controlled by such devices as cams or rocker-bar arms.

Any combination of two, three, or more different synthetic filaments may be used as the component members of the composite yarn. Also, the yarns of the same polymer in two or more different yarn counts or pre-

dyed and undyed yarns of the same or different polymers may be used in making up the composite structure.

Preferably combinations of components for use in this invention include nylon with rayon; nylon with acrylic fibres; polyethylene terephthalate fibre with rayon, acetate or acrylic fibres; acrylic fibres with rayon or acetate; and nylon with silk or glass fibres.

The process may be carried out continuously with other textile treating procedures, such as twisting, drawing or back-winding.

The following Examples illustrate specific embodiments of the invention. Throughout these Examples, in referring to any yarn the denier is placed first, the number of filaments in the yarn second and the twist, S or Z, if given, is placed third.

#### EXAMPLE I

Two continuous-filament textile yarns are fed simultaneously to a yarn-bulking jet of the type described in British Patent No. 842742 using air as bulking fluid at sonic velocity. One yarn, a 200 denier, 64 filament blue-dyed cellulose acetate of zero twist, is fed to the jet at 29½ yards per minute while the other, a 200 denier, 34 filament white nylon yarn with ½ turn of Z twist per inch is fed at 57 yards per minute. The yarns are bulked in the jet and the composite structure wound up at 28 yards per minute. The composite structure is rewound on a downtwister with 7 turns of Z twist at 30 yards per minute. In the rewinding process, tension caused by the downtwister breaks the acetate filaments and elongates the nylon filaments, removing all crumpled loops from the nylon. The result is a slub-type yarn with a smooth nylon core, random lengths of discontinuous bulked acetate filaments being intimately interentangled with the nylon core filaments. This composite slub yarn is woven into a plain-weave fabric with a warp of 70-34 "Dacron" (R.T.M.) polyester yarn to give a material with a pronounced slub effect in which only the slubs are blue.

#### EXAMPLE II

The same jet device is used as in Example I. Three following yarn components are employed:

		Feed Rate
Yarn	Count	(Yarns per minute)
55 Pink acetate	100-32-0	41.3
Pink acetate	200-64-0	57
White nylon	200-34-½ Z	100

The composite bulked yarn is wound up at 30 yards per minute and then broken as before on a downtwister. Both of the acetate yarns break, but with different frequency, giving a very random slub effect.

#### EXAMPLE III

The procedure of Example I is followed, except that in place of the acetate yarn, a

rayon yarn, 100 denier, 34 filaments, 2½ Z twist, is used, and in place of the nylon yarn, a polyethylene terephthalate yarn of 70 denier, 34 filaments, ½ Z twist. After breakage, the rayon yarn becomes a slub component on a core of polyester filament.

#### EXAMPLE IV

The procedure of Example I is followed, except that the nylon yarn is replaced by an acrylic continuous filament yarn, 200-80-0.3 Z.

#### EXAMPLE V

Two continuous-filament textile yarns are fed simultaneously into an air jet as described in Example I. One yarn, a 75 denier, 24 filament, zero twist navy blue acetate yarn is fed at a rate of 35.5 yards per minute, the other yarn, a 70 denier, 34 filament, ½ Z twist nylon yarn, at a rate of about 425 yards per minute. These yarns are bulked in the air jet at an air pressure of 35 psig.

In the resulting bulked yarn the nylon yarn is intimately interentangled with the acetate yarn, the nylon yarn constituting a core element. As the bulked yarn is removed from the air jet at a wind-up speed of 425 yards per minute, the acetate yarn breaks randomly along its length and is wrapped slightly around the nylon yarn, which has been elongated during its removal from the air jet.

The resulting yarn is then passed into the 1/8 inch passageway of a wrapping jet. Air is forced into this orifice through a 1/16 inch orifice at a rate of 40 psig, tangentially of the first orifice. Upon close examination, this yarn shows a plurality of distinct bundles of discontinuous acetate filaments wrapped completely around the nylon yarn. Under microscope giving a magnification of 10 times, the discontinuous acetate slubs are seen to be intimately intertangled with the nylon yarn core. Some of the individual slubs encircle the nylon yarn core in both S and Z directions, one twist being superimposed over the other.

After inspection, the composite slub yarn is woven into a plain weave fabric with a warp of 70-34 count polyethylene terephthalate fibre yarn to give a decorative material with a pronounced effect produced by the blue acetate slubs.

#### EXAMPLE VI

The procedure of Example V is repeated except that a 55 denier, 18 filament, zero twist bright acetate yarn is substituted for the navy blue acetate yarn and a 40 denier and 13 filament, ½ Z twist nylon yarn is substituted for the nylon yarn. The feed rate of the acetate component is 27 yards per minute, the rate of the nylon component and wind-up speed being the same as in Example VII. The air jet pressure is 55 psig, the wrapping jet pressure being the same. Both

visual and microscopic examination indicate a similar slub yarn is obtained. When woven into a plain weave fabric with the same polyester yarn, a decorative fabric with a pronounced slub effect is obtained.

#### EXAMPLE VII

The procedure of Example V is repeated except that 40 denier, 20 filament, 2.5 S twist dull rayon yarn is substituted for the acetate yarn and 70 denier, 34 filament,  $\frac{1}{2}$  Z twist nylon is used. The feed rate of the rayon component is 52.5 yards per minute, the feed rate of the nylon component being 840 yards per minute. The yarn is removed from the air jet (operating at a pressure of 15 psig) at a wind-up speed of 840 yards per minute and fed into a wrapping jet operating at an air pressure of 30 psig. Again it is noted that the slubs are separate and distinct bundles of discontinuous filaments wrapped completely around the nylon yarn core. Microscopic examination as before shows an intimate interentanglement between the slubs and the core. The phenomenon of right and left twist, seen in the product of Example V is again noticed.

A plain-weave fabric is prepared as before to provide a decorative material showing the slub effect.

#### EXAMPLE VIII

The general procedure of Example V is repeated except that 110 denier, 36 filament, zero twist bright acetate is substituted for the navy blue acetate and 210 denier, 34 filament,  $\frac{3}{5}$  Z twist nylon is used. The feed rates of the acetate component and nylon component are 27 and 425 yards per minute respectively. The wind-up speed is the same, the air jet and wrapping jet air pressures being 54 and 44 psi respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, although the slubs are just slightly shorter in length than those produced in Example V. A similar woven fabric is obtained.

#### EXAMPLE IX

The general procedure of Example V is repeated except that 40 denier, 20 filament, 2.5 Z twist dull rayon yarn is substituted for the acetate yarn and 70 denier, 34 filament, zero twist polyethylene terephthalate yarn is substituted for the nylon yarn. The feed rates of the rayon and polyester yarns are 27 and 425 yards per minute respectively. The wind-up speed is the same, the air jet and wrapping jet air pressures being 15 and 30 psi respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, except that the slubs are slightly shorter, as in Example VIII. A similar woven fabric is obtained.

#### WHAT WE CLAIM IS:—

1. A process for the production of a varying denier composite yarns, which comprises feeding at least two groups of con-

tinuous filaments simultaneously through a turbulent fluid zone at such different rates of feed that the extensibility factor of one group is substantially higher than that of another and stretching the composite material sufficiently to break the filaments of the group or groups of lower extensibility factor to form at random intervals along the length of the yarn distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

2. A process for the production of a varying denier composite yarn, which comprises feeding at least two groups of continuous filaments simultaneously through a turbulent fluid zone at different rates of feed to produce a bulky composite yarn in which the extensibility factor of one group of filaments is substantially higher than that of another and subsequently stretching the composite product sufficiently to break the filaments of the group or groups of lower extensibility factor to form at random intervals along the length of the yarn distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

3. A process for the production of a varying denier composite yarn, which comprises feeding at least two groups of continuous filaments simultaneously to a turbulent fluid zone at such different rates of feed to make the extensibility factor of one group, at a rate of withdrawal of the composite material lower than such feed rates, substantially higher than that of another group and withdrawing the composite material from the turbulent zone at such a high rate that filaments of the group or groups of lower extensibility factor are broken and form at random intervals along the length of the yarns distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

4. A process according to claim 3, wherein the filaments having the lower extensibility factor are broken by withdrawing the composite yarn from the turbulent zone at a rate approximately equal to the feed rate of the remaining filaments.

5. A process as claimed in any of claims 1-4, wherein one of the groups of filaments is fed at a rate at least twice that of another group of filaments.

6. A process as claimed in any of claims 1-5, wherein the composite product is passed through a zone of fluid torque to consolidate the bundles tightly round the higher extensibility component.

7. A process as claimed in any of the preceding claims, wherein the group of filaments of higher extensibility factor consists of continuous filaments of a synthetic organic polymer and remain unbroken after the stretching.

8. A process for the production of a varying denier yarn, substantially as described in any of Examples I-IV.
9. A process for the production of a varying denier yarn, substantially as described in any of Examples V-IX.
10. A varying denier composite yarn, produced by a process as claimed in any of claims 1-9.
- 10 11. A composite yarn of varying denier comprising a core yarn composed of filaments which may be substantially straight or convoluted and disposed at intervals and at random along the length of said core yarn distinct bundles of discontinuous filaments 15 entangled with the filaments of the core yarn.
12. A composite yarn as claimed in claim 11, wherein the discontinuous filaments are wrapped round the core yarn in addition to 20 being entangled therewith.

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Published at The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.



FIG. 1

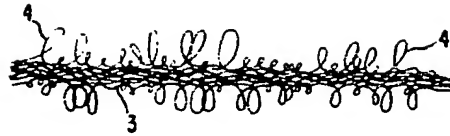


FIG. 3

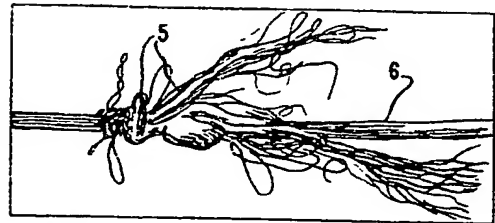


FIG. 2

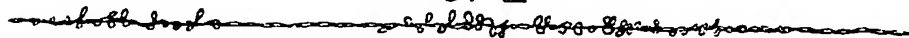


FIG. 5

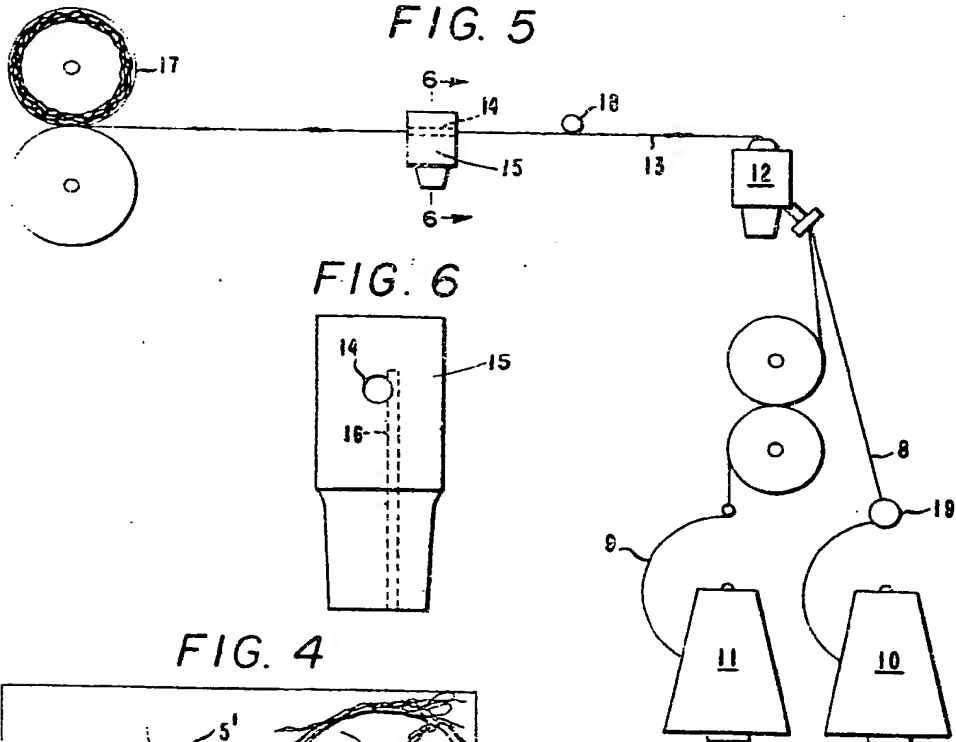


FIG. 6

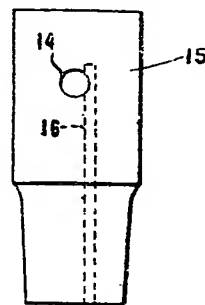
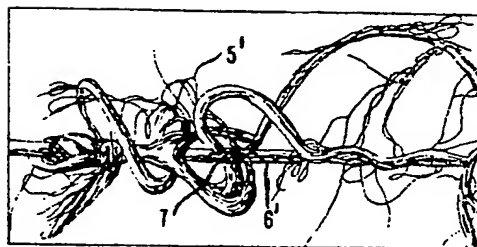


FIG. 4



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